Harding Lawson Associates

HLA

September 29, 1998

Mr. Gary N. Yamamoto, P.E., Chief
California Department of Health Services
South Coastal Region
Drinking Water Field Operations Branch
1449 West Temple Street, Room 202
Los Angeles, California 90026

Re: Response to Comments
Phase I Treatability Study Draft Report
Perchlorate in Groundwater
Baldwin Park Operable Unit

Dear Mr. Yamamoto:

Attached you will find a copy of our revised report "Draft Final Phase 1 Treatability Study Report, Perchlorate in Groundwater, Baldwin Park Operable Unit, San Gabriel Basin." We believe this draft addresses comments submitted by the California Department of Health Services (DHS) dated July 10, 1998. U.S. E.P.A.'s (EPA) comments and the Baldwin Park Operable Unit Steering Committee's (BPOUSC) responses are included as Appendices G and H. Responses to your department's comments on the Phase 2 Treatability Study Work Plan will follow under separate cover. Your comments followed by our responses to DHS are detailed below.

1. Bacteria are responsible for using the nitrate and perchlorate as an electron donor thereby facilitating the oxidation and ultimately the removal of nitrate and perchlorate. The report briefly mentions the biomass control unit without providing the details regarding what is the microbial density maintained in the biofilm (or bioreactor), how to control the biofilm, and what is the quantitative parameter used for the control.

   Response: The biofilm is not controlled directly; environmental conditions control the characteristics of the biofilm. The microbial density of the biofilm was not measured. The bed height control unit mechanically controls the maximum biomass bed height; operational details of the bed height control unit are confidential business information. Information on the bioreactor conditions which influence biofilm performance are provided in the report.

2. The conclusions of the report (page 14) state that "the conceptual model agrees well with the actual results. A sound conceptual model assists with interim and full-scale design." A conceptual model was provided in page 6 of the report, which clearly indicates that substrate utilization is a function of microbial density and the characters of the bio-particle (carbon media plus biofilm). There is no discussion regarding how the model was used, how the parameters for the model were derived, what were the values of the model parameters, and how well the model predicted changes in reactor performance. We could not locate the information regarding the microbial density, the size of the bio-particle, and the reaction rate constant.

Response: The fluidized bioreactor model has been removed from the report. Initial perchlorate concentrations were so low that it was not possible to gather sufficient data to confirm the model postulated in Bailey and Ollis. The size of the bioparticle was estimated to be 2 mm. Microbial density was not measured. The reaction rate constant was not calculated directly; however, the required reactor residence time was.

The report briefly discusses the stoichiometric equations for substrate utilization and the competing nature of various electron acceptors (dissolved oxygen, nitrate, perchlorate etc.). No attempt was made to discuss which substrate was the limiting species in the overall process of nitrate/perchlorate destruction and how to derive optimized ethanol loading accordingly.

Response: The data generally supports that consumption of dissolved oxygen occurs first and that nitrate destruction generally occurred more rapidly than perchlorate destruction. Therefore, perchlorate concentration in the effluent was used as a gauge of the limiting species in the overall process of nitrate and perchlorate destruction. Therefore, the optimized ethanol loading rate was derived by reducing substrate concentration until perchlorate destruction ceased.

If a scaled-down bioreactor is going to be used in Phase 2 study, tracer studies of the reactor, with and without recycle, should be performed in Phase 2 as the equation on page 6 is for a plug-flow reactor. With re-circulation and due to the tower and solid handling unit, the hydraulic characteristic of this reactor may lie between a completely-mixed reactor and plug-flow reactor.

Response: As the technology proceeds to full-scale implementation, "modular" bioreactors will be used. The bioreactor proposed for the Phase 2 study will be a "modular" bioreactor with a capacity similar to that planned for the full scale system. The Phase 2 study is planned with tracer studies to evaluate the hydraulic characteristics of the reactor module.

3. We would like to see information on cell yields and an attempt to close a mass balance on perchlorate, i.e., to account for where it is going. A mass balance would be a good way to build confidence in the results and the ability to identify the pathways of removal.

Response: Due to limits of laboratory technology for species thought to be intermediate perchlorate breakdown products (chlorate, chlorite, and hypochlorile) and due to the low perchlorate concentration in the study and presence of moderate background levels of chloride, an accurate mass balance could not be performed nor were cell yields estimated. Additional work will be conducted on this in Phase 2; however, given the anticipated perchlorate concentration in the San Gabriel Valley, we may not be able to calculate an accurate mass balance in Phase 2.

4. The report states that little or no sensitivity to temperature was observed. Literatures such as those cited in the report's reference list indicate that coefficients used to model biological reactors follow Arrenhius type temperature dependence. It is not surprising that no sensitivity to temperature was observed as the short time frame of these experiments and continual changing of variables may have masked any influence of temperature.

   Response: We agree that it is unlikely the temperature could be isolated as a single variable given the other variability in the study. The study did confirm that it is likely that biological activity will be stable at the temperatures present in the San Gabriel Valley.

5. In the executive summary (last bullet) and the last paragraph on page 13, the phrase "These results demonstrate that with disinfection and filtration..." should be deleted. These studies were not conducted with disinfection and filtration on the finished water, and therefore, there is no basis for such a conclusion.

   Response: This statement has been modified to: The study demonstrated that water produced from the intended treatment train will potentially meet State and Federal potable water standards. Additional work is needed to evaluate disinfection and filtration and demonstrate that the treatment processes will reliably produce potable water.

   The last paragraph on page 13 states "analysis of bioreactor influent and effluent for the full range of water quality parameters required under Title 22 was performed. Results are reported in Appendix D." We could not located the full range of Title 22 water quality parameters analysis results in Appendix D.

   Response: The Treatment train effluent was tested for Primary and Secondary State and Federal potable water quality standards on 5/18 and 6/15. The results are presented in Appendix D.

   We agree that a multi-barrier treatment, equivalent to what is required to meet the Surface Water Treatment Rule (SWTR) requirements is the minimum that may be required. As it was discussed in a previous meeting with Aerojet and HLA, some work on disinfection by-product (DBP) production needs to be conducted. The presence of low molecular weight compounds (ethanol and methanol) may result in significant DBP production when strong oxidizing agents (e.g. chlorine) are used to disinfect the water.

   Response: Phase 2 will evaluate a multi-barrier treatment, equivalent to what is required to meet the Surface Water Treatment Rule (SWTR). Phase 2 will also evaluate DBP production.

6. On page 12, the report indicates that it took 2 days or longer to establish a complete perchlorate and nitrate destruction after a startup of the system. This means any upset of the bioreactor could leave the water utility without water for an extended period of time, unless sufficient storage or emergency sources is [sic] available. This should be considered prior to the installation of the system for any water utility. The startup and shutdown procedures for the bioreactor need to be detailed in the operations manual.

   Response: Design of a system for use by a water utility will contain the level of redundancies and back up systems necessary to ensure a reliable source of water. The design for the Phase 2 system contains redundance in the form of liquid phase granular activated carbon. This will provide 8 to 12 days of perchlorate adsorption. All start up and shut down procedures will be detailed in the operations manual.

7. Page 13 states that "Analytical results shown in Appendix D demonstrate that with an influent ethanol concentration of 60 to 70 mg/L, ethanol in bioreactor effluent was less than the 5 mg/L laboratory reporting limit." However, there were only five instances when the ethanol concentrations were between 60 and 70 mg/L, among which only two had the effluent concentration report less than 5 mg/L. There are no sufficient data to support such a conclusion.

   Response: Work conducted after the draft report was issued indicated that the minimum influent ethanol concentration was approximately 40 mg/L. At this influent concentration, ethanol was generally absent from the effluent. In the Phase 2 treatment train the bioreactor will be followed by a biologically active multimedia filter and UV/Oxidation. Therefore, residual ethanol, if present in bioreactor effluent, will be degraded before the water exists the treatment plant.

8. On page 14, in the conclusion under bullet 4, the report states "Laboratory analysis indicated a lack of pathogens that may be of concern." What were the exact pathogens that were analyzed? We would like to have a copy of the analysis result.

   Response: The text has been revised to "...Laboratory analysis indicated a general lack of coliform and fecal coliform; however, further evaluation of filtration and disinfection of the effluent will be necessary to ensure that potable water quality standards are reliably met. A copy of a typical analysis result is attached; the full analysis results are summarized in Appendix D.

9. The analysis results in Appendix E indicates that the existence of acetone and other ketones in the bioreactor influent. Also, acetone concentration increased after the bioreactor. What is the source of acetone? What happened in the bioreactor?

Response: The ketones and isopropyl alcohol appear to have originated in the alcohol. On 2/11/98 the ethanol was sampled: ethanol >90%, methanol 30,000 mg/L (3%), isopropyl alcohol 53,000 mg/L (5.3%), and MIBK 8,200 mg/L (0.82%). The BPOUSC is evaluating the availability and expense of higher grades of alcohol. The Phase 2 treatment train should result in complete destruction of all ethanol impurities.

10. Several coliform analysis results in the Appendix D were reported as an MPN of coliform organisms of >200.5/100 mL. We would like to know what was the exact number of total coliform bacteria presented in the sample.

Response: No attempt was made to quantify MPN > 200.5. Quantification for MPN > 200.5/100 mL requires dilution of the sample or that the Quantitray method be used. The laboratory did not take these steps during sample analysis.

11. The bio-solid (sludge) generated from the bioreactor represents a substantial and important by-product of the total process. There is no discussion regarding to the rate of bio-solid production, the characteristic of bio-solid (such as the constituents of the bio-solid, percentage of dry solids, etc.) and bio-solid handling operation in the report. The impact of bio-solid handling operation operation should be evaluated.

Response: At the scale of the Phase 1 treatability study, the produced bio-solid was too low to measure, and therefore evaluate. The production, handling, and disposal of the bio-solid will be addressed during the Phase 2 treatability study.

Thank you for the opportunity to respond to your comments. We are looking forward to meeting with your staff next week. Please call me at (415) 899-8825 if we can assist you in any way.

Yours very truly,

HARDING LAWSON ASSOCIATES

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